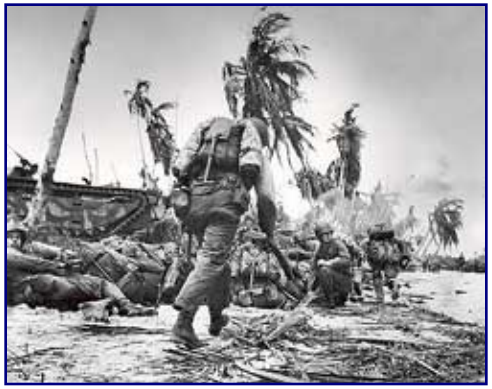
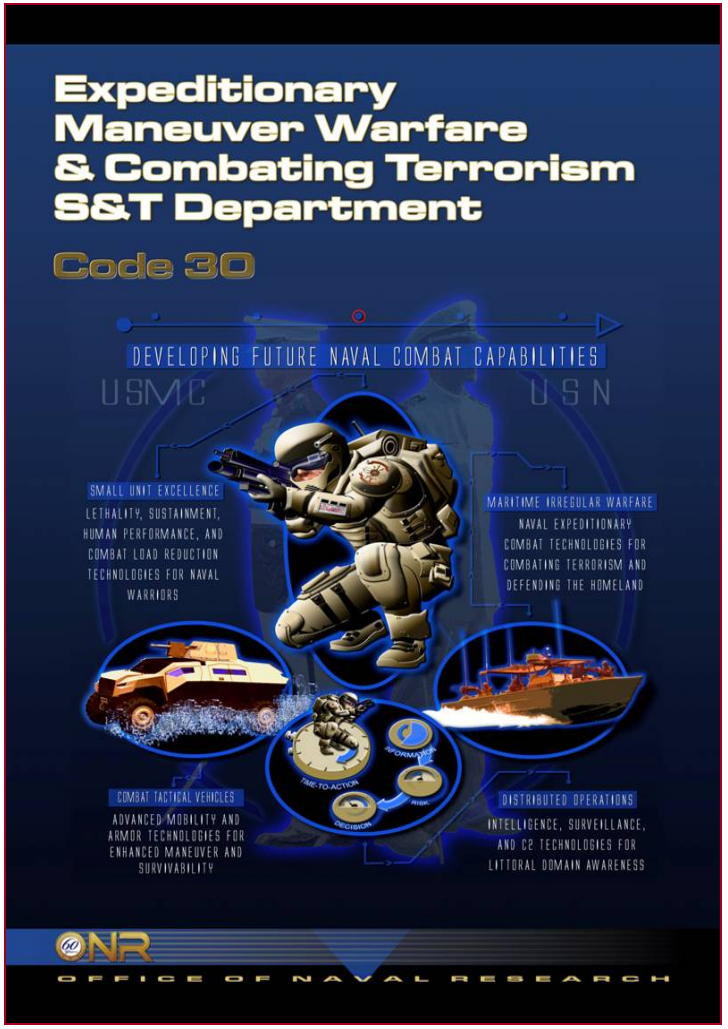
Revolutionary Research . . . Relevant Results



Preparing for the future….
Never forgetting the past!



Office of Naval Research Code 30
Thrust Area Willful Intents
FY12 - FY13

NCW/Interoperability TIA – Willful Intent

Current Capability:

- Network interoperability is achieved through manually configured gateways; networks are static and manually configured and managed
- For interoperability, systems are linked pair-wise. "One-size fits all" approaches are computationally cumbersome
- Authentication of users is centralized and require reachback; security associations are typically hardware-based and/or point-to-point
- Existing software applications do not tolerate the latency and intermittency of tactical networks

FY	Desired Capability	S&T Challenges	S&T Solution – TRL 5/6
Near Term FY13-FY15	• Networking and network management that support mobility inter- and intra-network; network access through multiple gateways • Ability to access and use information from multiple sources	• Managing complexity and dynamics of networks: optimization under uncertainty; relaxation mathematics • Devising adaptable data architecture that works over tactical networks and accepts both existing and future systems: object-oriented programming	• System Integration Environment uses object-based model providing translation into reference implementation and tactical network transport adaptation • DTCN EC: provides policy-based network management; adaptive routing and radio-router interface
Mid Term FY16-FY18	• Ready access to relevant information by appropriate users • Management of heterogeneous networks • Cross-domain security (software solution)	• Autonomously determining and locating needed data, and providing information products; providing disconnected services—distributed control algorithms • Representing network state in dynamic situations (within NW time constant): applying stateless techniques • Enabling scalability of flat networks while minimizing control overhead: non-monotonic logic • Providing key exchange and session management for intermittent networks	• Mission model with learning algorithms; EAITE EC Proposal FY14; server-less operations • Global optimization with local information • Alternative routing and transport (w/o TCP/IP): flow-based optimization • Layer 2/3 security sessions • End-to-end network state estimate
Far Term FY19-FY21	• Full system interoperability/information abstraction • Transparent mobility and mobile security	• Devising lightweight (low overhead), persistent information and network services: "scale-free" networks • Distributing authentication authority without compromising network security	• Mathematically provable software quality STTR • Network Theory & Fully Homomorphic Encryption • Co-development of information, network and security theory (YIP); understanding system complexity • Robust Trust Models • Value of information (STTR?)

Endstate:

- Rapid discovery, usability, and secure exchange of <u>needed</u> information by all users.

OTH/Gateways TIA – Willful Intent

Current Capability:

- Proliferation of radios and antennas in vehicles provide a significant visible signature; Mobile command center architectures do not support emerging needs or forthcoming network radios
- Tactical allocation of military SATCOM is low-priority; Commercial SATCOM is expensive; SATCOM can be jammed; RF spectrum is crowded
- Mobile command centers require high-throughput reach-back comms; SATCOM on-the-move terminals are expensive and are visual targets
- HF radio is unpredictable and low-throughput

FY	Desired Capability	S&T Challenge	S&T Solution – TRL 5/6
Near Term FY13-FY15	• Regimental-level mobile gateway with reachback	• Compact OTM SATCOM terminals: maintaining tracking with simplified INS without illuminating adjacent satellites (1-1/2^{o} apart) • Compact, modular airborne relay packages: reducing antenna co-site interference	• M2C2 • Beyond Line-of-Sight Tactical Communications Relay (completed); Software Reprogrammable Payload (SRP)
Mid Term FY16-FY18	• Compact multi-network communications gateway package • Alternatives to SATCOM for backbone links • Improved HF communications	• Reducing number and size of broadband antennas (λ/2 dipole antenna rule-of-thumb); Low SWAP VHF/UHF RF components (Isolation of frequencies and Tx/Rx; minimize reflections and IM distortion • Optical Communications - Reducing terminal cost and complexity: optics and tracking systems • Multi-function relay: developing software radio architecture that can manage power, dynamic range and frequency range differences • HF communications - Improving SNR and channel capacity	• Meta-material compact antennas; • Using platform as radiator and platform coupling of antennas; • Characteristic Modes STTR; • High Power Hopping Filter SBIR; RF to photonics to RF • High-performance tunable filters • Laser Comms EC • SRP wideband • HF MIMO :Advanced channel models and estimates • Compact HF Antennas STTR (completed)
Far Term FY19-FY21	• Mobile platoon with battalion-level information capabilities	• Reliable higher-throughput OTH communications within weight, size and power constraints • Broadband PAs are inefficient: Improving impedance matching over *f* band	• Broadband Tx/Rx isolation: ferrites and device architectures • Advanced Amplifier materials: graphene

Endstate:

- Bi-directional high-throughput reachback and terrestrial communications for Regiment and below.

Small Unit Technologies TIA – Willful Intent

Current Capability:

- Tactical communications are unreliable and range-limited in restricted environments (i.e., cities, forests, valleys, caves)
- Low cost software radio platforms do not meet military security requirements; Antennas are not adaptable to changing needs and conditions
- Vital situational awareness information is manually provided to small unit Warfighters and often does not meet needs
- It is not possible to provide an adequate communications, positioning, and C2/SA/decision support capability to individual distributed Warfighters within low-SWAP and cost constraints

FY	Desired Capability	S&T Challenge	S&T Solution – TRL 5/6
Near Term FY13-FY15	• Provide ability to manage multiple levels of security on a single device • Assured connectivity	• Adequate, verifiable, partitioning of classified and unclassified processors, memory, data bus • Maintaining link margin in high-interference, high attenuation environments: SNR improvement	• Software radio security architecture SBIR • Very-narrow bandwidth communications (complete)
Mid Term FY16-FY18	• Radios and antennas that automatically adapt to the situation (include support of 3G/4G and tactical SATCOM) • Automated provision of tactically relevant information • RF-based position location	• Complexity of mode optimization; compactness of antennas: exploiting the “slow-wave” phenomenon (L-C ratio) in small apertures • Operating over intermittent, low-throughput networks • Relative position only, dependent on radio BW and SNR: managing/exploiting multipath	• Adaptable mode radio – maximizes throughput/ • minimizes energy; parasitic element antennas • Machine learning; contextual content management • Distributed computing/hybrid computing • Quasi-absolute position: belief-based learning & RF mapping
Far Term FY19-FY21	• High-assurance ,efficient, information exchange with & within small units	• Physical limitation of broadband antenna miniaturization: impedance; pattern control (Chu and Fano limits) • Channel capacity is asymptotically approaching Shannon limit • Methods of automatically labeling information for meaning, e.g.- ontologies, are manually generated	• Closely coupled radiators (YIP) • Polarimetric communications; advanced non-Gaussian encoders/decoders; interference alignment • Information salience STTR: automatic generation of ontology-like structures

Endstate:

- Battalion-level situational awareness, intelligence products, and decision support provided to distributed small units.